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Monterey Sheriff Camp Roberts v6

NAVAL POSTGRADUATE SCHOOL
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Field Demonstration

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On Thursday, August 21st, 2008, the California Homeland Security Consortium (CHSC), in cooperation with the CENETIX lab at the Naval Post Graduate School (NPS) and the Monterey County Sheriff's Office, successfully streamed real-time, high-resolution video to a Tactical Operations Center (TOC)[1] from a helicopter flying at an altitude of 1,500 feet and a distance of 4.9 miles.

While this appears to be a very simple task often seen on network television, in reality, it is part of a situational awareness environment that has been studied by CENETIX over the past five years along with Tactical Network Topology (TNT) experimentation sponsored by USSOCOM. Also, as the helicopter moves around and the network expands, antenna steering or switching to the closest wireless mesh node on the ground could become necessary to maintain quality of the video.

Currently, the Monterey County Sheriff's Office has a helicopter-mounted, high-resolution video camera that provides the crew members with an aerial view of the ground beneath the helicopter. The camera is controlled by Sheriff's Office Tactical Flight Officer (TFO) and a display in the cockpit facilitates the TFO's ability to report back what he or she sees (often involving something occurring on the highway, a crime scene, or other critical event) to the TOC via a voice communications link. The captured video is also stored on a DVD-type recorder, located in the helicopter cockpit.

Because the video is stored in the cockpit, the helicopter must land, and the video file(s) must be physically transferred to the TOC via disk or by uploading the video file(s) to a terrestrial network once on the ground. This creates a significant delay between the capturing and viewing of the video and limits its use for posting investigation activities. A lack of real-time access to the Monterey County Sheriff's Office helicopter video feed limits the Sheriffs' ability to generate a Common Operating Picture

[1] The TOC will probably be a supervisor's patrol car or mobile command post near the incident scene when the initial system is deployed to the Sheriff's Office with future expansion envisioned to reach Monterey County's Emergency Operations Center in Salinas, CA.

(COP) that could be shared with other responding agencies and to enhance Situational Awareness (SA) for improved coordination and decision making. Sergeant Denis Greathead of the Homeland Security Division of the Monterey County Sheriff's Office reiterates, "Our current method involves explaining the situation verbally via an unsecured radio frequency. We can also videotape an incident, and if there happens to be a location close by to land safely we can try to land and pass off the tape, and then go back to recording the incident. As you can see that would be 'delayed' footage not 'real-time' and it would involve coordination regarding the passing off of the tapes, the video player, etc. And if there isn't a place to land safely close by, that would not be an option."

In seeking to provide the Monterey County Sheriff's Office with real-time video feed capabilities, Dr. Thomas Housel, executive director of CHSC sponsored a field demonstration in cooperation with Dr. Alex Bordetsky, executive director of CENETIX at NPS; and Doug Dahmen, Commander & Terrorism Liaison Officer for the Monterey County Sheriff's Office. The objective of the experiment was to demonstrate remote, wireless, high-resolution video transmission from the Monterey Sheriff's helicopter at various altitudes and distances from the command center.

Field Demonstration

The primary goal of the field demonstration was to stream video in real time from the Sheriffs' helicopter to a TOC, and secondarily, to enable the TFO to focus on controlling the camera, rather than having to exert energy to describe and relay what is occurring on the ground.

There are several approaches that could be used to achieve successful video streaming. One such approach would be to point one high-powered directional antenna from the helicopter toward the tactical operations center and another from the tactical operations center toward the helicopter, and the two antennas would continually follow each other and transmit information using Orthogonal Frequency Division Multiplexing (OFDM) mesh radio signals. Using this approach would allow for a very strong directed signal, with the transmission being spread over only five degrees, and a long transmission range of 40 miles or more.

While this approach can be effective, it is also quite expensive. Some of the more expensive elements are a result of the helicopter antenna setup, such as a steerable antenna placed inside the aircraft for the purpose of maintaining the link with the ground antenna, and a stabilizing platform for the camera so that it can maintain the direction at which it is pointing, regardless of the revolution of the aircraft. In order to complete this setup, the helicopter would need to be significantly modified from its current manufactured state.

Given the expense of an OFDM setup, the CENETIX team recommended the use of one high-powered directional ground antenna that points toward an omni directional antenna mounted on the helicopter. With an omni directional antenna, the transmission distance would range from three to five miles, due to energy being used by transmitting the signal in a 360 degree pattern; however the cost of this type of configuration is significantly less expensive (averaging $27k) than the use of two high-powered directional antennas. Also, this less expensive tactical network can be extended and

made scalable through adding nodes to a fixed broadband wireless network, adding mobile extensions that create a wireless broadband mesh, and/or through mobile augmentation using private cellular networks.

In future field demonstrations, CENETIX will be testing the quality of the OFDM mesh radio signals, to measure distance throughput constraints.

Functional Constraints

The conditions of the demo setup were not ideal, because Camp Roberts is covered with repeater nodes, and it was not as simple as measuring the length of the signal between only two nodes—one being the antenna on the helicopter and the other being the antenna on the ground. The test team also had to take into consideration the effects of the repeater nodes the helicopter encountered as it roamed.

As a result, the CENETIX team attempted to cancel out the signal-boosting contribution of the repeater nodes by placing a third person in the helicopter who was able to see on his screen which node he was transmitting to at any given moment, which enabled them to attain a close-to-real measurement of single antenna system. This is critical to understanding how a single network link will perform. During the demo, the pilots flew away from Camp Roberts, past the final repeater node, until the signal was lost. When the signal began to weaken, there was a degradation of quality in the video, and eventually, it stopped streaming; once this point had been reached, they knew that the bandwidth had become too narrow to transmit video. This last node was the final point of measure.

The wireless communication technology used to transmit video between the TOC and the helicopter mounted high-resolution camera was wave relay OFDM, which was transmitted over a broadband mesh network. Wave relay OFDM is capable of delivering 6-30Mbps throughput over distances ranging from 5-60 miles. Both the distance and throughput are moderated by the topology of the terrain. However, the behavior of such a piloted wireless aerial node is less known and requires further experimental studies

Findings

The Monterey County Sheriffs' helicopter-mounted camera, coupled with the CENETIX wireless communication equipment, successfully transmitted real-time, high-resolution video to the TOC. Successful transmission of video occurred at altitudes of 500 feet, 1000 feet, and 1,500 feet, with a distance ranging from less than 1 mile to 4.9 miles from the TOC. This field demonstration was limited to the use of one omni directional antenna mounted on the sheriff's helicopter and one directional antenna located in the TOC. If existing, county-owned radio antennas are utilized and the network is extended throughout Monterey County, it would provide the Sheriff's office with countywide video streaming capacities from its helicopter-mounted camera.

The cost of creating a single, high-bandwidth link between a helicopter and a ground -based command center with a range of 3-5 miles is approximately $27,000.

Assuming that a high-resolution camera is already mounted to the helicopter, the following equipment is required:

Helicopter
Omni Attend / Radio System $5,000
Analog Video Digitizer $2,000

Ground-based Command Center
Directional Antenna / Radio System $5,000
Directional Antenna Mount $15,000

Extending the network beyond a single ground station to a helicopter-mounted camera link may be accomplish using three overlapping strategies: 1) adding additional nodes to a fixed broadband wireless network; 2) adding a mobile extension that creates a wireless broadband mesh; 3) Mobile augmentation using private cellular networks.

Future Action
The overarching objective of CHSC, in cooperation with NPS's CENETIX program, and its industry partners is to develop a "model county" national hub in the Monterey Bay area, and to conduct field trials of technology, operational processes, policies, and doctrines, in cooperation with participating agencies at all levels of government and industry. In line with the CHSC's objectives, Dr. Thomas Housel informed CDR Dahmen that once Dr. Alex Bordetsky has completed his testing of the Tactical Network Topology and provided him with a set of equipment specifications, the CHSC would work with the county to procure all of the network communication equipment and a maintenance contract for the equipment.

Sergeant Greathead and the rest of the Monterey County Sheriff's Office are very excited about the potential of the technology and equipment. In a recent email, Sergeant Greathead stated, "This equipment would allow us to send 'real-time' video feeds to a Command Post, which would allow the decision makers to see first-hand immediate footage about what is occurring. They say a picture is worth 1,000 words and that is what this is all about – providing a real time picture."